SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1903.

GENERAL PHYSICS.

774. *Determination of Surface Tension by Capillary Waves.* **A. Pockels.** (Phys. Zeitschr. 4. p. 182, Nov. 15, 1902.)—Grunmach, in his paper on this subject to the Naturforscherversammlung at Karlsbad [see Abstract No. 697 (1903)], says that possibly error may be introduced by the platinum point which dips into the liquid. The author points out that this may be obviated by first heating the point for an instant to red heat, and that in any case will be negligible on account of the very small size of the point. In the case of water and aqueous solutions, deviations from the normal value of the surface tension are always due to the presence of fatty or other organic substances on the surface. W. S.

775. *The Formation of Drops in Smoke.* **A. Thiel** and **F. Abegg.** (Phys. Zeitschr. 4. pp. 129–132, Nov. 15, 1902.)—The phenomena were observed by using a glass box in the top of which was a circular opening which could be varied in size or closed entirely. The glass box was filled nearly to the top with a required gas, in the first experiments carbon dioxide. Directly above the circular opening was a glass cylinder containing air or other gas rendered smoky by ammonium chloride. The upper end of this cylinder was closed by an air-tight piston. When the piston was pushed down the smoky air descended into the glass box and lay for a short time in thick clouds on the upper surface of the carbon dioxide. Soon it fell in drops through the latter gas. Each drop afterwards split into two, each of the two latter gave rise to two others, and so on till the bottom of the glass box was reached. Successive divisions took place in perpendicular planes. The phenomenon goes on with much greater rapidity when hydrogen charged with ammonium chloride drops through air or carbon dioxide. The appearance when smoky air drops through hydrogen is also described and illustrated. W. S.

776. *Barometry of the United States, Canada, and the West Indies.* **F. H. Bigelow.** (Report of the Chief of the U. S. Weather Bureau, Vol. II., pp. 1–1005, 1900–1901. Prepared under the direction of W. L. Moore, Chief of Weather Bureau, by F. H. Bigelow, Washington, 1902.)—This report contains a revision of the meteorological data which have become available since the opening of the Government service in 1871. The records for Canada are furnished by R. F. Stuart, director of the Canadian Meteorological Service, and the report was compiled with the assistance of H. L. Heiskell, and further of Miss Hawkins and Miss Sellers. The volume contains the material necessary for computing daily weather maps on three planes—the sea-level, the 3,500-ft., and the 10,000-ft. planes, further normal values of the air pressures, temperatures, and vapour tensions at the stations and on these three planes. As was explained in Abstract No. 1503 (1902), a new system for the reduction of barometric pressures has, with January 1, 1902, been put in operation in the United States, Canada, and the West Indies. This volume reviews the system of plateau barometric reductions formerly in use, the Guyot tables (1870–1881), Abbe-Upton constants, Ferrel tables, Ferrel-Hazen tables, Hazen tables, and Morrill tables (not previously published). In Chapter II. reduction formulæ are deduced and tables given in English measures for the reduction of station pressures to any plane between sea-level and 10,000 ft. Chapter III. tabulates the station pressure normals computed for January 1, 1900, based in many cases on twenty-seven years' records; such normals are to be recomputed at intervals of ten years. Repeated surveys having brought out discrepancies in elevations, all observations are for each individual station reduced to the elevation of Henry Gannett's geological survey of 1899. This chapter further explains the compilation of mean diurnal values from observations at a few selected hours which have several times been changed, and concludes with tables on the geographical position, elevation, and corrections to be applied to the several instruments in each of the 242 stations of the United States and the West Indies. Chapter IV. discusses temperature gradients in latitude, longitude, and altitude, and temperature charts for the three planes. The chief centres for the reductions are eighteen geographical crossing-points of degrees of latitude and longitude. Local gradients are first obtained for the three co-ordinate directions, all stations between 0 and 1,000 ft. being reduced to the 500-ft. level, &c. These vertical reductions to 500, 1,500, 6,500 ft. give, by extrapolation downward, the respective probable sea-level temperature through which a system of balanced isothermals is drawn. This horizontal system checks the vertical system for the centres of reduction, and the normal temperature can, for each station, be traced upward, again starting from the sea-level temperature. Cloud computations and balloon and kite records are available for the 10,000-ft. plane, but the author emphasises that much remains to be done with regard to vertical temperature gradients in the free air. Chapter V. deals with the vapour tension, which is considered more valuable for forecasting than relative humidity, dew-point, and sensible temperature; the vapour tension is deduced from the humidity with the aid of Smithsonian tables. Chapter VI. reproduces the records of the stations and the corresponding normal sea-level pressures for each month and the year; the data from twenty-five Canadian stations are also tabulated. Chapter VII. explains the construction of the charts for the three planes. In Chapter VIII. the normal values are summarised for all the stations. Chapter IX. prints the special tables prepared for the instruction of the staffs of all these individual stations. Chapter X. finally tabulates and discusses the annual and secular variations, the stations of the United States and the West Indies being for this purpose collected in ten groups. Apart from the minor maxima and minima, the annual means indicate a distinct axis of influence in January–July (maximum pressure in January, minor maximum in July), and a feeble axis of influence in April–October; this rectangular system would lag behind the solstice-equinox axes by about one month. As regards the secular variation (only U. S. stations considered), there were years of high pressure in 1874–75, 1882–3, 1890, 1896–7, with an interval of about eight years; the intervening low-pressure years are separated by the same interval. The volume is illustrated by a very large number of charts. H. B.

777. *The Spectrum of the Aurora Borealis.* **J. Sykora.** (Acad. Sci. St. Pétersburg, Mém. 11. 9. pp. 1–7, 1902.)—Ten photographs were taken of the aurora spectrum in Spitsbergen, but of these five were useless, owing to great temperature changes taking place during the exposures. The remaining five were very good, and on being measured gave the following results:—

λ		λ	
557·0	Characteristic Green	405·7	
471·0		399·5	
442·9	Weak	391·2	Characteristic Ultra Violet
435·4		380·4	
427·6	Characteristic Violet	375·4	
419·0	Weak	370·7	Weak
408·3			

E. C. C. B.

778. *A New Spectroscopic Binary, ε Aurigæ.* **H. C. Vogel.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 48. pp. 1068–1069, Nov. 27, 1902.)—A series of photographs taken at Potsdam of the spectra of this star show without doubt that it is a binary and, further, that it has a very long period. E. C. C. B.

REFERENCES.

779. *Knife-edge Suspensions.* **G. Guglielmo.** (Accad. Lincei, Atti, 11. pp. 263–271, Nov. 16, 1902.)—Methods for finding the radii of curvature of the two sides of the knife-edge suspension of a balance or pendulum and discussion of the errors introduced by these. A. D.

780. *Air Pump Design.* **C. L. Brown.** (Elect. Engin. 30. pp. 692–693, Nov. 14; 733–734, Nov. 21; and Elect. Engin. Supplement, 30. pp. 5–8, Dec. 12, 1902.)—The paper consists of general notes on the subject.

781. *Meteorological Observations made at the Perth Observatory and other places in Western Australia in* 1901 *under the Direction of W. E. Cooke.* (20. pp. 5–135, 1902.)

782. *The Spectroscopic Binary a' Geminorum.* **A. Belopolsky.** (Acad. Sci. St. Pétersburg, Mém. 11. 4. pp. 1–111, 1902.)—This paper contains the computations of the radial velocity and the period of this binary from a number of spectrum photographs taken at Pulkowa between the years 1894 and 1899. E. C. C. B.

783. *Photometric Observations of Nova Persei.* **L. Grabowski.** (Acad. Sci. St. Pétersburg, Mém. 12. 9. pp. 1–33, 1902.)—The results of a series of observations made at Pulkowa with a 5-in. Steinheil refractor fitted with a Zöllner photometer, comparison being made between the Nova and fixed stars of known intensity. E. C. C. B.

LIGHT.

784. *Elementary Explanation of Illumination in Optical Instruments.* **H. Krüss.** (Zeitschr. Instrumentenk., Beib. 23. pp. 245–249, Dec. 1, and 24. pp. 254–257. Dec. 15, 1902. From Report read before the Zweigverein Hamburg-Altona.)—The illumination of images produced by lenses is treated in an elementary manner, and the method is extended to apply to telescopes and microscopes. It is shown that the image seen in a telescope has the same brightness as that seen by the naked eye, telescope and eye being treated as one optical instrument. Thus, the eye-piece and the lens of the eye are represented by one lens, and the retina by a plane screen at a constant distance behind the lens. In a microscope the illumination is, for the same magnification, proportional to the angular aperture. Finally, numbers are given for the percentage of light lost by reflection at and absorption in the lens, the loss being 8 per cent. for one lens with $\mu = 1{\cdot}5$, 26 per cent. for four such lenses, and 15 per cent. for one lens of $\mu = 1{\cdot}8$, the incidence being normal. G. E. A.

785. *Theorem in Geometrical Optics.* **R. Straubel.** (Deutsch. Phys. Gesell., Verh. 4. 13. pp. 328–334, Sept. 24, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—The theorem is proved that if a pencil of rays of aperture dw (confined to a plane) diverge from a point, and if its breadth at any point on its path be ds', then any other pencil proceeding back from a point in ds' and having an aperture dw', its breadth at the first point being ds, the relation between the two pencils is given by $\mu\, ds\, dw = \mu'\, ds'\, dw'$, where μ and μ' are the refractive indices at the two points. The path of the pencil is constructed according to the principle of least time. If dw and dw' represent solid angles and ds, ds' sectional areas, the theorem becomes $\mu^2\, ds\, dw = \mu'^2\, ds'\, dw'$. The theorem is shown to be applicable to photometry and to the dioptrics of the atmosphere. G. E. A.

786. *Relation between Absorption and Resolving Power.* **R. Straubel.** (Phys. Zeitschr. 4. 1 b. pp. 74–76; Discussion, p. 76, Oct. 10, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad.)—The problem of the dependence of the resolving power of an ideal optical instrument on absorption is treated mathematically, the two simplest and most important cases being taken, viz., that of a prism or prism system and that of a lens or system of lenses. In the discussion it was stated that anomalous dispersion could not be brought about solely by means of varying absorption in the prism. G. E. A.

787. *Apparatus for Testing Quartz Plates.* **E. Brodhun** and **O. Schönrock.** (Zeitschr. Instrumentenk. 22. pp. 353–372, Dec., 1902. Communicated by the Physikalisch-Technischen Reichsanstalt.)—A very full description is given of the result of investigations which have been carried on at the Reichsanstalt since 1898 for the purpose of obtaining apparatus by means of which quartz plates can be quickly and accurately tested with regard to their optical purity, plane-parallelism, and axis error. Optical purity is tested by means of a polarisation apparatus with quartz wedges. The position of the latter is such that any flaws they may possess are either not visible or they only cause a slight illumination of the field when adjustment is made for darkness. The quartz to be tested having been put in place in a homogeneous white field, and the nicols crossed, the rotation is increased as much as possible by means of the compensators, and by added quartz plates, and in the resulting darkened field, any faulty places in the quartz appear plainly. Experience shows that plates are very seldom found greater than 20 mm. in diameter, and 5 mm. in thickness, which prove perfectly homogeneous when tested by the above method. It is difficult enough to find pure material for saccharimeter quartzes (up to 1·6 mm. thick). For these, the middle portion, at least 9 mm. in diameter, must be sufficiently pure. Parallelism of the surfaces is tested by observation of Fizeau's bands or Haidinger's rings, by means of Lummer's method (Wied. Ann., vol. 23. p. 49, 1884), whilst planeness is tested by observing the Fizeau bands formed by an air layer about 0·4 mm. thick bounded on one side by the quartz plate and on the other by a plane glass plate. The apparatus for measuring the axis error, or angle between normal and optic axis [see Abstract No. 832 (1902)] is next described. The plate is examined by means of a kind of polarimeter, and is capable, when in position, of rotation round a vertical axis in the centre of the instrument while movable also in its own plane. These two motions taking place simultaneously, the difference between the two limiting angles of incidence, ϕ_1 and ϕ_2, is read off, and, if $\phi\ (=(\phi_1+\phi_2)/2)$ is about 40°, the expression for the error reduces to $0{\cdot}3(\phi_1-\phi_2)$. The necessary adjustments are fully described, with drawings of the instrument and examples of the measurement of the axis error for two quartz plates. G. E. A.

788. *Relation between Objective Distance and Stereoscopic Effect in Field-Glasses.* **O. Hecker.** (Zeitschr. Instrumentenk. 22. pp. 372–374, Dec., 1902.)—From a formula of Helmholtz's it is deduced that Δe, the smallest distance between two objects in the line of sight for which it can be perceived that there is a difference in distance, and d, the distance between the two objectives of the field-glass, are so related that $\Delta e=\frac{C}{d}$, where C is a constant. A Zeiss prismatic field-glass was employed in determining, for different values of d, the range of error made in adjusting one upright needle to the same distance from the eye as two others placed on either side of the line of sight, and the experiments made by two observers verified the above relation, Δe being the range of error. The magnification employed was 8, and the objective distance could be varied between 63 and 113 mm. G. E. A.

789. *Application of Hartmann's Method of Zonal Testing to Astronomical Objectives.* II. **H. Lehmann.** (Zeitschr. Instrumentenk. 22. pp. 325–330, Nov., 1902.)—The author here supplements the general account in his former paper [see Abstract No. 2031 (1902)] by some detailed information regarding the working of the method, and various applications to very fine measurement where its great accuracy renders it of utility. In testing the differences of foci of the zones of an objective of aperture 108 mm. and focus 2,160 mm., a probable error of only 3 to 7 hundred thousandths of the focal length was found. Further, the outer zone, just the one which most requires testing, is found with greatest accuracy. One useful purpose to which the method was applied was to measure the injurious effect, long known to exist, of placing the different glasses of a compound lens in actual contact. It was found that this reduced the resolving power by one-third, with monochromatic light. The necessity for a well-fitting mounting was shown by the presence of astigmatism due to deficiency in this respect, and which the ordinary eye tests failed to disclose. Again, owing to the mode of manufacture, the outermost zone of a lens is apt to have greater curvature than the central region. In the *retouche* process for curing this, Hartmann's method is of great service. When the curvature increases regularly from centre to edge, the error may be compensated, in the case of uncemented objectives, by placing the component lenses further apart than calculation dictates. Thus a doublet of 40 mm. ap. and 60 cm. focus was made twice as good as before by increasing this interval from 0·2 mm. to 1 mm. The method is also useful in testing plane-parallel glasses, and colour filters, as regards homogeneity, &c. The author qualifies his former statement respecting the correction of objectives used in monochromatic light for spherical aberration only. A. E.

790. *An Interference Phenomenon seen with Lippmann's Colour Photographs.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 4. 16. pp. 377–378, Nov. 14, 1902.)—Each portion of an ideal spectrum photograph taken by Lippmann's method should theoretically reflect quite homogeneous light; this reflected light will of course be missing from the transmitted light. The author examined some photographs taken at the Physical Institute at Berlin, and found they showed this phenomenon well. A photograph of a continuous spectrum was placed against the slit of a spectroscope, and when white light was used, a sharp absorption band was seen, which moved along the spectrum when the photograph was moved over the slit. Conversely, a Lippmann photograph of a bright line spectrum was taken, and the light reflected from each line was examined in a spectroscope; in each case a bright line on a perfectly dark background was seen. E. C. C. B

791. *Commercial Accuracy of Photometrical Measurements.* **C. H. Sharp.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1493–1499; Discussion, pp. 1500–1509, Nov., 1902.)—The author deals with the question of the possibility of ensuring that photometrical measurements, as ordinarily carried out under working conditions, shall be accurate to within 2 per cent. He first examined two standard Hefner lamps, which had been made in Germany and bore the stamp of the Reichsanstalt. They were compared with electrical standards on fourteen different occasions. The mean difference between the lamps was 1·2 per cent: but the mean readings given by the two lamps were almost exactly the same. On two occasions, the differences between the lamps were as much as 5·2 and 3·9 per cent.; this showed that one of the lamps was not burning under normal conditions. A table is given showing the various readings, together with the corrections for humidity. If the mean indication of the pair of lamps is taken as correct, the mean deviation was 1 per cent., and the maximum 2·5 per cent. The Hefner unit is supposed to be 0·88 c.p., without correcting for humidity, the correction for humidity having been only determined of late; the author finds under these conditions that the mean of the two Hefners in his possession gives 0·884 c.p. A pentane lamp was also examined, which was known to be imperfect; but its readings, which are also given, were as consistent as those of the Hefner. The maximum deviation from the mean was 4·05 per cent. for the corrected readings, and the mean deviation was 1·1 per cent., *i.e.*, supposing that the deviations had been always in one direction. The next point was to examine the accuracy with which photometric standard incandescent lamps can be

reproduced. A table is given showing readings of the voltage at which each of ten lamps gives 16 c.p., these readings being made on five occasions by different observers. The greatest mean deviation from the mean for any lamp was 0·07 per cent. in voltage, corresponding to about 0·05 c.p. Lastly the accuracy of ordinary commercial measurements on incandescent lamps was tested. Ten lamps were tested by four persons on four different photometers in the ordinary course of work. The greatest deviation of a single measurement from the mean of the four was 2·5 per cent. W. H. S.

792. *Persistence of Images in the Retina.* **M. Dupont.** (Comptes Rendus, 135. pp. 876–878, Nov. 17, 1902.)—Apparatus based on looking at a source of light and at its image in a prism, the light being alternately cut off from the eye and from the prism by the vibration of a tuning-fork of adjustable frequency. If the vibrations of the fork be rapid enough, two images are seen steadily; if they be slow enough, the two images are seen alternately; when a flicker begins to appear, the two images are each seen for the period of persistence. This period varies very much according to the state of health; and the method is an aid to diagnosis. A. D.

793. *Photographic Emulsions and Plates.* **K. Schaum** and **V. Bellach.** (Phys. Zeitschr. 4. pp. 4–7, Oct. 1, 1902.)—During the ripening of emulsions, there is an increase in the size of the Ag Br particles, and also a slight reduction of the Ag Br by the gelatine. The Ag Br particles become larger and fewer, the smallest being dissolved and deposited on the larger; and the initial mere opalescence of the emulsion becomes opacity. Higher temperatures, or the presence of electrolytes which increase the solubility of Ag Br, favour this process. With fresh Székely emulsion the average apparent area of a granule is $0\cdot72\mu^2$, after two hours' ripening it is $5\cdot9\mu^2$. With Eder's silver-oxide-and-ammonia-emulsion the figures are 1·2 and 8·1; with Apollo emulsion 1·5 to $9\cdot0\mu^2$. On drying there is a shrinkage of the Ag Br granules. The average number of granules in the surface layer is 270,000 per sq. mm. The thickness of the gelatine of dry plates ranges from 0·0138 mm. (Ertee diapositive) to 0·0522 (Perutz orthochromatic). With Schleussner normal dry plates the superficial layer of the film has particles few and small; below this the developed plate has silver particles many and large, but nearer the glass these are again fewer and smaller. The number of silver particles per sq. mm. of the superficial layer is of the order 80,000, and is within wide limits independent both of the duration of the exposure and of that of the development. The total number of silver granules in the whole thickness of the film is of the order 200,000 per sq. mm. and remains the same under constant periods of development, whatever the exposure; while with varying periods of development it varies in the same sense, but not proportionately. Every silver granule corresponds to a pre-existing Ag Br granule, and there is no spontaneous separation of silver in the gelatine during development. A. D.

794. *Binocular Microscope.* **F. E. Ives.** (Frank. Inst., Journ. 154. pp. 441–445, Dec., 1902.)—New binocular attachments to ordinary short-tube microscope; capable of being used as a non-stereoscopic (sending both eyes images practically identical with the single image of a monocular) or as a stereoscopic binocular. In the latter case there is no exaggeration, and high powers can be used. The pupillary distance and the centreing of the two images are adjusted separately. By adjusting the distance between the eyepieces the change from stereoscopic to non-stereoscopic and to pseudoscopic vision can be effected ; and the same can be done by holding the eyes within or without the plane of the eyepoints. A. D.

795. *New Device for Stereoscopic Photomicrography.* **F. E. Ives.** (Frank. Inst., Journ. 154. pp. 391–393, Nov., 1902.)—A one-plate one-exposure stereoscopic photo-micrographic camera is made with a light telescopic box camera for plates $3\frac{1}{4}$ × 6 in. In front is a small box containing three equilateral prisms, one of which is small and is placed so that the light from the eyepiece of the microscope passes normally through one face. Reflection at the other two faces takes place, and the other two prisms direct the beams so formed on to the two halves of the sensitive plate. G. E. A.

796. *Optical Power of Organic Compounds.* **L. Tschugaeff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 6a. pp. 606–622, 1902.)—The object of this paper is firstly to confirm, by means of some novel data, the relations previously enunciated by the author himself, with regard to the behaviour of the molecular rotation, and, secondly, to make some remarks on certain observations made in connection with this problem by other experimenters. After showing the importance of always considering molecular rotations instead of specific rotations, the author goes on to test the first of the above empirical relations, viz., that the nearer (from a stereo-chemical point of view) the non-active substituent is to the active asymmetrical complex (particularly to the asymmetrical carbon atom), the more important is its influence on the magnitude of the rotation. This influence, as the distance of the substituent increases, is gradually weakened, and finally vanishes completely. This *principle of position*, as the author terms it, gives a simple interpretation of another rule, which is observed in homological series of optically active compounds, viz., that from a certain term of the series, a further increase in the molecular weight of the substituent ceases to exert any appreciable influence on the molecular optical power $[M]_D$, the latter thus becoming practically constant. Both laws are found to represent satisfactorily the experimental results of the author and others. A. G.

797. *Zeeman Effect.* **A. Färber.** (Ann. d. Physik, 9. 4. pp. 886–898, Nov. 1902. Tübingen Dissertation, Abstract.)—The splitting apart of the lines investigated (4678·37 Cd and 4680·38 Zn) is proportional to the field up to a field-strength of 24,000 C.G.S. The value of $10^{-5}\Delta\lambda/\lambda^2H$ for these lines is 18·18, within 1 per cent. A. D.

798. *Radio-activity of Air.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 4. pp. 96–99, Oct. 15, 1902. Papers read before the Atmospheric Electricity Committee of Associated Academies at Göttingen, May 15 and 16, 1902.)—In the bounding layer between the air and the soil there is a constant production of ions and Becquerel radiations. Portable apparatus, by Elster and Geitel, is briefly described. Running a wire (Al, Pb, Cu, but Pt in cellar air, not in the open) positively charged through a region of high electric dispersivity produces induced radio-activity, about $\frac{1}{30}$ that found when the wire is negatively charged. Disturbances in the readings of apparatus, due to residual phenomena, are discussed. A. D.

799. *Portable Apparatus for Determination of Radio-activity of the Atmosphere.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 4. pp. 138–140, Nov. 15

1902.)—The authors describe a convenient portable form of battery and electroscope for the above work. The battery consists of a 6,000-pair dry-pile of so-called gold and silver paper, arranged in thirty small piles each of 75 volts, fitted in a metal box. The electroscope is of the Braun type, but fitted with internal amber insulation and an arrangement for preserving the inside dry by a sodium preparation. E. H. B.

800. *Loss of Weight by Radio-active Substances.* **A. Heydweiller.** (Phys. Zeitschr. 4. pp. 81–82, Oct. 15, 1902.)—Five grammes of a "concentrated" radio-active substance from de Haën, List-Hannover, sealed in an alkali-free Jena glass tube, were found to lose no less than 0·02 mgr. weight per 24 hours steadily. The amount of energy radiated, 5 ergs. per sq. cm. per second (Becquerel), comes in this specimen to 10^7 ergs. per 24 hours, and the whole potential gravitational energy of the 0·2 mgr. comes to $1{\cdot}2 \times 10^7$ ergs. every 24 hours. It would seem, therefore, that with radium we have a direct transformation of the potential gravitational energy into radio-energy. This idea is compatible with vortex-atom conceptions and with the seat of the process being in the structure of the atom. A. D.

REFERENCES.

801. *Value of some Magneto-Optical Constants.* **J. J. Hallo.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 535–539, Jan. 31, 1903.)—In his dissertation on the *Magnetic Rotation of the Polarisation-plane in the Neighbourhood of an Absorption Band* (Amsterdam, 1902), the author had calculated for a given case the values of three of the constants occurring in Voigt's theory of magneto-optical phenomena. As one of these constants had already been determined by Drude in his *Lehrbuch der Optik* (Leipzig, 1900), the author here compares his results with his own. A. G.

802. *Simple Diffraction and Polarisation Apparatus.* **W. B. Croft.** (Nature, 66. pp. 354–355, Aug. 7, 1902.)—The author describes simple arrangements by means of which diffraction and polarisation phenomena can be viewed and photographed. G. W. DE T.

803. *Photography as applied to Illustration and Printing.* **J. D. Geddes.** (Soc. Arts, Journ. 50. pp. 829–834, Sept. 19; 842–846, Sept. 26; and pp. 853–858, Oct. 3, 1902.)—The author deals with the various processes of photographic printing, both in monotint and in colours. G. W. DE T.

804. *Photography as applied to Illustration and Printing.* **D. C. Dallas.** (Soc. Arts, Journ. 50. pp. 925–926, Nov. 7, 1902.)—This paper, which is supplementary to that dealt with in the previous Abstract, deals with trichromatic photographic printing. G. W. DE T.

805. *Corrections to Gilbert's Tables of Fresnel's Integrals.* **d'Ocagne.** (Journ. de Physique, 1. pp. 507–508, Aug., 1902.)—The author here gives a list of errata which he has noted in these tables. G. W. DE T.

806. *Radium.* **F. Giesel.** (Phys. Zeitschr. 3. pp. 578–579, Sept. 15, 1902.)—The preparation of radium chloride is described: when approaching purity it gives a carmine red flame instead of the green of barium. The spectrum has two bright lines in the red, one bright line in the blue, and two fainter ones in the violet. The spark spectrum is probably not the same as the flame spectrum. A. D.

HEAT.

807. *Differential Method of Determining Small Freezing-point Depressions.* **H. Hausrath.** (Ann. d. Physik, 9. 3. pp. 522–554, Oct., 1902. Extract from Göttingen Dissertation.)—The apparatus employed consisted of two freezing vessels placed side by side under similar conditions in a trough which was completely surrounded by the cooling bath; one vessel contained the experimental solution, the other the pure solvent, and the difference of freezing temperature in the two vessels was determined accurately to a few hundred thousandths of a degree by means of a thermoelectric arrangement,

For both non-electrolytes (carbamide, cane sugar, alcohol) and electrolytes (nitrates of lead and barium, sulphates of hydrogen, copper, zinc, magnesium, nickel and cadmium, chlorides of sodium and hydrogen, caustic potash, acetic acid and dichloracetic acid) series of determinations were made of the molecular depression of very dilute solutions. Urea was found to obey Raoult's law even in the most dilute solutions (0·0005 normal). Cane sugar gave the molecular depression 1·872, though (possibly due to experimental error) there was found to be an increase in the value in the case of the most dilute solutions. Alcohol gave uncertain and abnormally low values—down to 1·574. The salts of the heavy metals mentioned above do not furnish any certain evidence of hydrolytic dissociation, so that, for instance, the observed depressions for the most dilute solutions of lead nitrate coincide with those for barium nitrate, which is certainly not dissociated to any appreciable extent. On the contrary cadmium sulphate exhibits association even in still very dilute solutions as the values of the depression show. The strong electrolytes, NaCl, HCl, H_2SO_4, KOH, and also dichloracetic acid give molecular depressions much below the value, 3·70, for complete dissociation, and it is remarkable that the values reach a maximum in each case at a concentration of about 0·007 normal. D. H. J.

808. *Variation of the Specific Heat of Metals with Temperature.* **W. Gaede.** (Phys. Zeitschr. 4. pp. 105–106, Nov. 1, 1902. Extract from Freiburg Dissertation.)—The metals were shaped as circular cylinders with a central cylindrical hole filled with mercury, into which was dipped a copper rod, embedded in, but insulated from, which were wires of constantan and copper. An electric current through the one heated the arrangement, and the electric resistance of the other measured the temperature. The accuracy of the method is about 0·1 per cent. Measures were made about 17°, 33°, 47°, 62°, 77°, 92° C. on Sb, Pb, Cd, Cu, Pt, Hg, Zn, Sn, steel, and showed that, if the specific heat is represented by $c/c_0 = 1 + at + bt^2$, b is negative for all the metals and a is positive except for Hg. The results found for Pt are smaller than those given by any other observer—doubtless because the Pt was purer. R. E. B.

809. *Latent Heat of Evaporation of Mercury.* **W. Kurbatoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 7a. pp. 659–666, 1902.)—A determination of the latent heat of evaporation of mercury is important, primarily on account of the use of mercury in various measurements; moreover, it would give a value of Trouton's constant, and, accordingly, a means of ascertaining whether mercury is an associated liquid and whether complex particles can exist in a substance with metallic conductivity. The method employed is that of mixtures, this being the most simple and reliable. The average of four determinations is found to be $\varrho = 67\cdot8$, with an uncertainty less than 1 per cent., Trouton's constant thus taking the value $K_T = 21\cdot5$. It may be inferred from this value that liquid mercury is non-associated at its boiling-point. As the boiling-curve of mercury is well known from Regnault's, Carnelly's, and Ramsay's researches, the density of saturated mercury vapour at the boiling-point, calculated by means of the Clausius-Clapeyron formula, is found to be 100·3, which only differs slightly from the theoretical value. Finally, the specific heat of mercury, decreasing up to 250°, again increases as the temperature approaches the boiling-point, C_{20}^{340}, being $= 0\cdot0378$. [See also Abstract No. 2225 (1902).] **A. G.**

310. *Influence of Temperature on the Elasticity of the Elements.* **C. Schaefer.** (Ann. d. Physik, 9. 3. pp. 665–676, Oct., 1902.)—The author formerly [see Abstract No. 2377 (1900)] determined the temperature coefficients of the moduli of elasticity and torsion in the case of ten metals (Pt, Pd, Fe, Ni, Au, Cu, Ag, Al, Zn, Pb) and found, *e.g.*, that between —200° C. and 20° C., the moduli of elasticity were linear functions of the temperature; further, when the above metals were arranged in the order of increasing temperature coefficients of elasticity or torsion, they were also arranged in the order of increasing coefficients of expansion and decreasing melting-points. The author has now extended the investigation to the metals Cd, Mg, Sn, Ir, Rh, C—elements for which the change of the modulus of torsion with the temperature could be satisfactorily determined though they are not adapted for measurements of the temperature coefficient of elasticity. The following table summarises the results of the preceding and present measurements; the alkali metals have also been introduced :—

Element.	Coefficient of Expansion.	Modulus of Torsion.	Temperature coefficient of Modulus of Torsion.	Melting-point.
Carboneum	$0{,}0_5 50$	—	1,25	very high
Iridium	$0{,}0_5 70$	—	4,03	2,500°
Rhodium	$0{,}0_5 85$	—	3,69	2,000
Platinum	$0{,}0_5 907$	6,594	1,78	1,765
Palladium	$0{,}0_4 1104$	4,613	2,70	1,600
Ferrum	$0{,}0_4 1113$	7,337	3,035	1,500
Nickel	$0{,}0_4 1279$	9,518	3,28	1,400
Aurum	$0{,}0_4 1454$	—	3,01	1,070
Cuprum............	$0{,}0_4 1698$	3,967	4,49	1,100
Argentum	$0{,}0_4 1900$	2,667	3,21	970
Aluminium	$0{,}0_4 2336$	2,329	24,7	645
Magnesium	$0{,}0_4 2694$	1,181	30,2	600
Zinkum	$0{,}0_4 2905$	1,614	48,4	419
Plumbum	$0{,}0_4 2948$	550	78,7	327
Cadmium	$0{,}0_4 3060$	1,024	46,7	320
Stannum	—	—	82,0	230
Lithium	—	—	120,0	180
Natrium	$0{,}0_4 72$	—	130,0	90
Kalium	$0{,}0_4 83$	—	150,0	58
Rubidium	—	—	170,0	38
Cassium	—	—	180,0	26

It will be seen that except in the cases of Ir, Rh, Au, Cd, the author's previous generalisations are confirmed. If we plot the atomic weights of the elements examined against the coefficients of expansion and against the temperature coefficients of the moduli of torsion, we get curves quite similar to Lothar Meyer's atomic volume curve, and we may say that the above coefficients are periodic functions of the atomic weights. D. H. J.

811. *Passage of Heat through Surfaces.* **L. Austin.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1890–1894, Dec. 13, 1902. Communicated by the Physikalisch-Technische Reichanstalt.)—This is a continuation of the work of Holborn and Dittenberger [see Abstract No. 627 (1901)] with improvements in details, among other things, a flat plate of wrought iron, 3 cm. thick, being substituted for the brass cylindrical surface used before. The results are as follows: When heat passes from the metal to boiling water, the transition-resistance varies from 2 to 1·2 according to the character of the boiling, if the water be unstirred, the unit of resistance being that of 1 cm. of iron, but is reduced to about 0·75 with vigorous stirring; this resistance, for the same circumstances of stirring, seems to be independent of the heat-flux. For water not boiling, the transition-resistance may reach 10 if there be no stirring, but stirring brings it below 1; for the same circumstances of stirring, it increases somewhat, as the temperature of the water diminishes. When heat passes from the water to the metal, the transition-resistance is constant if the boiling is regular, and is the same as that in the reverse direction if the water be well stirred, but is otherwise somewhat larger. These results differ from those of Holborn and Dittenberger. R. E. B.

812. *Efflux of Saturated Steam.* **V. Blaess.** (Phys. Zeitschr. 4. pp. 82–85, Oct. 15, 1902.)—Dry saturated steam was allowed to flow through a simple nozzle, which could maintain between its ends any difference of pressure up to 9 atmospheres, and curves were drawn to represent the efflux per hour with the fixed initial pressures p_1 of 2, 3, ··· 9 atmospheres respectively, and with varying final pressures p. These curves are all similar, being nearly equilateral hyperbolæ for values of p/p_1 greater than 0·58, and for smaller values of p/p_1, being straight lines parallel to the pressure-axis, indicating that the efflux is not increased by diminishing the back-pressure below 0·58 of the initial pressure. If the nozzle is trumpet-ended, the maximum efflux occurs at a higher value of p. The author justifies these results by discussion of the ordinary formulæ for the speed w and quantity G of adiabatic efflux of a perfect gas, incidentally also pointing out that G has its maximum value when w changes direction at a point of inflexion. As the theory shows that the maximum speed of efflux is that of sound, Zeuner's theory of de Laval's steam turbine (which assumes for steam a speed of efflux of about 1,000 metres per sec.) cannot be right. R. E. B.

813. *Theory of Engines with several Vapours.* **K. Schreber.** (Phys. Zeitschr. 4. pp. 117–118, Nov. 1, 1902. Report read before the 74 Naturforscherversammlung at Carlsbad, Sept. 24, 1902.)—If we take the ratio of the efficiency of a vapour-engine with complete expansion between the temperatures T_1, T_0 (with $T_1 - T_0$ small), to the efficiency of a Carnot cycle with the same range, to be of the form $1-(c/r)f(T_1, T_0)$, where c is the specific heat of the liquid and r its heat of vaporisation, the best liquid to employ is that for which c/r is smallest, and the author finds that this is water, but that for high temperatures it is advisable to use aniline, and for low temperatures ethylamine; he therefore proposes the scheme: 310° aniline 190° water 80° ethylmine 20°, which will theoretically have 65 per cent. of the maximum efficiency for the range, but practically perhaps only 58 per cent. R. E. B.

SOUND.

814. *Sensitiveness of the Ear to Notes of Different Pitch.* **M. Wien.** (Phys. Zeitschr. 4. 16. pp. 69–73 ; Discussion, pp. 73–74, Oct. 10, 1902. Paper read before the 74 Naturforscherversammlung at Carlsbad, 1902.)—There is no sharp limit of frequency at which sounds become audible; vibrations as low as 10 and as high as 45,000 have been heard. The telephone serves as an indicator in which the travel of the disc is, within limits, and up to frequencies of about 2,000, proportional to the amplitude of the current variations; and this can be measured. The least current which will produce an audible tone at 64 vibrations is 0·0019 amperes, while at 1,024 vibrations it is 0·000000,18 amperes and at 16,000 vibrations it is 0·00012 amperes. The minimum corresponds to frequencies between 700 and 3,000; and the requisite current shows a range of 1 : 10,000 ; and the sensitiveness (inversely proportional to the *intensity* of the sound) for notes of different pitch shows a range of $10^8 : 1$. Examples are given of the use of the telephone in this way in aural diagnosis. Further apparatus and methods are described, for reduction of the sensitiveness to absolute units. The smallest vibratory amplitude rendered audible was $6{\cdot}3 \times 10^{-10}$ cm., much less than the molecular diameter. A. D.

815. *The Vowel "i."* **L. Bevier, Jun.** (Phys. Rev. 15. pp. 271–275, Nov., 1902.)—The sound is *i* (as in "pique"). The method employed has been explained in several communications [see Abstracts Nos. 1451 (1900) and No. 321 (1903)]. In this case there is (1) a powerful upper-partial at about frequency 2,050 ; (2) a chord-tone present with large amplitude. It is characteristic that besides these two there is practically no intermediate resonance. P. E. S.

REFERENCES.

816. *Reproduction of Wax Phonograms for Phonographic Museums by Galvanoplastic Moulding.* **L. Azoulay.** (Comptes Rendus, 135. pp. 879–880, Nov. 17, 1902.)—The "Commission for Phonographic Archives," of the Vienna Academy of Sciences, has already published an account of the fusion process employed for the multiplication of disc phonograms. The author gives details of the multiplication of cylinder records. The original phonogram (in wax) is used to obtain a galvanoplastic mould in copper. Wax at a particular temperature is introduced into the mould and pressed into it by pneumatic or other pressure exerted from the centre of the wax cylinder. D. H. J.

817. *Sound.* **J. Tuma.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 402–410, 1902.)—Preliminary note on resonator apparatus for a method of comparing loudnesses of sound and of estimating the reflecting power of different materials by building up a resonator with one of its surfaces consisting of the material to be tested. A. D.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

818. *The Electric Origin of Molecular Attraction.* **W. Sutherland.** (Phil. Mag. 4. pp. 625–645, Dec., 1902.)—The author has elsewhere advocated the hypothesis that molecules attract each other with a force proportional to the inverse fourth power of the distance. That is found to be the law of mutual attraction or repulsion of two magnets or electric doublets, whose length is very small compared with the distance between their centres. He begins this paper by showing how the attractive forces are (in a sense) of more importance than the precisely equal and similar repulsive forces—in effect because mutually attracting molecules tend to approach each other and so to increase the force, whereas repulsive molecules tend to recede from each other. According to Boltzmann's $\epsilon^{-2h\chi}$ law, the molecules, if in any degree free to choose, tend to place themselves in a configuration in which χ is minimum, so that the attracting molecules will get as near to one another as they can. The writer follows Helmholtz in supposing that every chemical bond consists of two electrons of opposite signs, so that the junction of atom to atom involves the existence of an electric doublet. He gives a list of his own previous papers which are to be interpreted in the light of the present one. In section (1) he deals with the law of force between doublets referring to the works of Tait and Maxwell. He corrects an erroneous conclusion that might be drawn from the law between two parallel doublets whose directions make angle θ with their join, namely $3m_1m_2(2\cos^2\theta - \sin^2\theta)/r^4$. The correction consists shortly in pointing out that the number of values *cæteris paribus* between $\theta + \theta + d\theta$ is proportional to $\sin\theta$. A subsection (1*a*) is devoted to the range of molecular force. Van der Waal's or Neumann's law for potential $\frac{f}{r}\epsilon^{-\frac{r}{\lambda}}$ is considered, in which $\lambda = H/K$ the ratio of Laplace's capillary parameters. He proposes an approximation in the absence of exact knowledge of the function of the distance—namely, that for distances greater than the mean molecular distance and less than a certain distance Δ, we should use the inverse fourth power of r. In section 2 he refers to an equation given in Phil. Mag. [5] 39. pp. 25–45, namely—

$$a^e/n = (\rho/n + \sigma)^e. \quad \ldots\ldots\ldots\ldots\ldots \quad \text{(A)}$$

which "means that the mutual energy of two molecules of the type considered divided by the number of equivalents in each can be obtained by regarding each equivalent as a separate attracting entity." This agrees with the electric theory in the special case where the axes of the electric doublets are all directed the same way. In section 3 is discussed the relation of the theory to Helmholtz's theory of chemical valence. This is with special reference to the work of Richarz, who calculated the charge e on a doublet necessary to account for the work done in dissociating N_2O_4 into $2NO_2$, and he gives an example of the same kind. In section 4 is considered the period of rotation of an electric doublet. [There seems to be a mistake in the equations, p. 638, owing probably to a misprint.] Section 5 is an elaboration of the chemical

theory of the electric doublet as applied to different substances. Section 6, on molecular couples and gyrostats, is based on the couples which doublets exert on each other, tending to bring their axes into the same direction. It suggests a kinetic theory of solids [see Phil. Mag. 5. 32], but goes in this paper no further than suggestion. Also a theory of dielectric capacity, in which electric doublets will play the most important part, and a systematic development of an electrical theory of thermochemistry on Helmholtz's lines.
S. H. B.

819. *Analogy between Quantity of Electricity and Entropy.* **N. A. Hesehus.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 6b. pp. 325–329, 1902.)—Attention has been drawn for some time to the analogy existing between electric potentials and temperatures. The author examines the question, Which thermal quantity corresponds to a quantity of electricity? In a previous paper he had shown that if thermal phenomena had originally been investigated by the same means as electrical phenomena, if, *e.g.*, in similar researches a small thermoelectric cell, or any other small differential thermometer playing the part of the electrical testing-disc, had been employed, the conclusion might have been arrived at that heat was present only on the external surface of bodies, whereas in the interior, no matter what the temperature of the latter, no heat was found. In that case a different theory of heat, with laws different from those now adopted, would have been established, and new terms have presented themselves. By "amount of heat," or "thermic charge," as one might have put it, we should have understood a quantity analogous to "entropy." O. Wiedeburg, in fact, showed the dimensions of electrical—and accordingly *thermal*—charges to be the same as the dimensions of entropy. [See Abstract No. 1452 (1900).] A seeming contradiction, arising from the different behaviour of both quantities with regard to conservation, is solved by the author, who, according to Wiedeburg's views, introduces into his formulæ a special quantity, M or S. The latter, for thermal processes, will always coincide with Clausius' entropy in the case of an equilibrium state, but, in opposition to entropy, will obey the law of conservation. A. G.

820. *Electrical Air Currents.* **S. Lemström.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 6b. pp. 307–315, 1902.)—Whenever an electrical circuit is broken by a layer of air, electrical "air currents," as the author puts it, will be produced, provided the p.d. at the terminals of the circuit be strong enough to allow of this current being manifested. Independently of the remarkable features shown by this sort of current, the principal reason for introducing this new term into science was the prominent part played in nature by the phenomena connected with it. The author has for many years investigated these air currents, using an apparatus which was made up of an insulated wire, bearing points at intervals of 0·5 m. each, and wound in the shape of a wide spiral on a wooden bar. A second wire was connected to this, its free end leading to a galvanometer, the other terminal of which was connected to an earthed zinc plate. By means of this attachment it was possible to produce a luminous phenomenon wholly analogous to the *aurora borealis*, it being shown that the latter is due to the presence of electrical currents in the air. Further experiments were undertaken in order to investigate the properties of these currents and to show their intimate connection with the *aurora borealis*, the results arrived at being as follows: (1) The circuit is analogous to an ordinary circuit made up of metallic wires. The

greater part of its resistance is due to the apparatus itself, its magnitude varying with the atmospheric conditions. (2) Two such instruments placed at the same height give no deflection when connected through a galvanometer. (3) The resultant action of a system of two or more such instruments, placed at different heights, is found to be equal to the sum of their individual actions. (4) The electrical resistance of the "point apparatus" may be determined by the usual methods, the circumstances capable of altering it being eliminated (5) The resistance r of two instruments united through a galvanometer is practically equivalent to the sum of the resistances of the circuits made up of either instrument, the galvanometer and the zinc plate connected to earth. (6) The same is true of the magnitude $1/r$. Continuing his researches at different places, the author states that such currents are not confined to the Polar regions. The currents usually flow downwards, but this direction is frequently inverted. The p.d. may be measured by means of one or several Daniell elements inserted in circuits made up of point apparatus, galvanometer, and earth plate. The artificial *aurora borealis* would be observed in any direction, evidence being given of the electric air current causing the air itself to glow. The atmospheric currents will undergo nearly continuous variations ranging within rather wide limits. The variations become more frequent as the maximum auroral zone is approached. The relation between the currents and the *aurora* appears to be very intimate, the variations of current always augmenting in the case of this phenomenon being observed. In Polar countries the p.ds. of atmospheric currents are very small as compared with those simultaneously observed with the electrometer. The essential difference between the two phenomena is clearly shown by a comparative inspection of the respective curves, which, though showing certain analogies with regard to their general features, represent some notable differences as to details. As regards the resistance of air, this, of course, depends first of all on the water vapour it contains, principally on the condensed portions suspended in it. As the humidity increases, the density of the positive current gradually decreases, until rain falls, when the current changes sign, and afterwards fluctuates in direction and magnitude. After the rain has ceased, the negative current falls to zero, then becomes positive, and gradually increases. The magnetic elements exert considerable effect on these currents: the vertical current going from above downwards will impart to the magnetic needle an easterly deflection if the current flows to its north, and a westerly deflection in the inverse case. A further interesting fact is the *influence* of the currents in question *on vegetation*. In Polar countries an extraordinary development of the latter is observed in the course of the brief summer; the author ascribes this fact to the action of the air currents. The author also describes some experiments with artificially produced air currents, the main results being as follows: (1) Water and salt solutions, placed in capillary tubes in the neighbourhood of the circuit, are raised, this influence being observed at a distance of 0·75 m. (2) Electrical air currents, emanating from a point, will produce chemical combinations—ozone, nitric, and nitrous acids, and, very likely, ammonia. Experiments on plants tend to show that negative currents raise the sap in the capillary vessels, and that positive currents not only produce the above-mentioned chemical combinations, but similarly to negative currents, introduce them into their capillary tubes. (3) If the current emanates from a point located at the upper end of a conductor, the lower end of which is connected with one of the poles of an electrical machine, while the other pole is earthed, and if the internal coatings of some Leyden jars form parts of a spherical surface surrounding the point, while the outer coatings are joined to earth, each jar will be changed to a potential depending on the position of the internal coating. [See also Abstract No. 1982 (1901).] A. G.

DISCHARGE AND OSCILLATIONS.

821. *Emanation from Phosphorus.* **F. Harms.** (Phys. Zeitschr. 4. pp. 111–113, Nov. 1, 1902.)—The author contests the conclusion of G. C. Schmidt [see Abstract No. 85 (1903)], viz., that no ions are formed during the oxidation of phosphorus, and that the conductivity induced by phosphorus in air is only apparent and is really a convection phenomenon due to small particles of suspended phosphorus or its oxidation products. He finds that the conductivity disappears in a shorter time after the removal of the phosphorus than would be probably required for the "convection" particles to settle from the atmosphere. He finds too that the increase of conductivity due to phosphorus is very similar to that due to flame, while a cloud of sal-ammoniac, on the other hand, rather diminishes than increases conductivity. D. H. J.

822. *Discharge of Electricity through Gases, and the Temperature of the Electrodes.* **J. A. Cunningham.** (Phil. Mag. 4. pp. 684–703, Dec., 1902.)—The author describes experiments in which he measured the fall of potential along the discharge column in a vacuum tube, when the pressure in the tube and the temperature of one of the electrodes were varied. The electrodes each consisted of a platinum wire bent backwards and forwards on itself so as to form a plane grating normal to the axis of the tube, and one of them could be artificially heated. Three intermediate electrodes are fixed at intervals along the discharge column. The temperature of the hot electrode was measured by means of a platinum platinum-rhodium thermo-couple, the wires being attached to adjacent bars of the grating. In a series of eight tables the author gives the measurements of the potential-fall along the discharge at different pressures, the temperature of the kathode being kept constant while the pressure was varied, but having a different value—ranging from 35° to 1,500° C.—in each set of observations. At low temperatures of the kathode, the kathode fall shows a well-marked minimum at a pressure of about 0·65 mm. of mercury; but at higher temperatures this minimum is less marked and occurs at a greater pressure. In fact, the kathode fall becomes almost independent of pressure above 0·5 mm. The curve for a temperature of 1,500° C. shows a steadily decreasing fall of potential close to the anode with decrease of pressure. The potential-gradient in the positive column is approximately proportional to the pressure above 0·5 mm. The gradient at the negative end of the positive column, and including the Faraday dark space, is very much less than anywhere else in the discharge, and seems almost to vanish at a pressure of about 0·65 mm. In six more tables are given the results for variation of temperature of the kathode at constant pressures. These show a very steep fall of potential at the kathode for low pressures, and exhibit the effect of variations of current on the potential-gradient in different parts of the discharge. For all values of the current greater than about $2\cdot5 \times 10^{-4}$ amperes, the potential fall along the positive end of the discharge—83·5 mm., the total distance between the electrodes being 139 mm.—was too small to be measured by any of the available instruments, and the gas in this part of the tube remained dark; but when the current fell gradually below that value, a brilliant yellow positive column began to rise up

from the anode and the potential fall increased very rapidly. On increasing the current, the potential-difference instantly fell off again to its former small immeasurable value. At high temperatures the kathode fall diminishes with increasing current. When the anode is the heated electrode, the anode fall shows a steady diminution with rising temperature. W. C. H.

823. *Kathode Rays and Lenard's Window.* **T. des Coudres.** (Phys. Zeitschr. 4. pp. 140–142, Nov. 15, 1902.)—The experimental results of Leithäuser as to the loss of speed experienced by kathode rays in traversing thin metal plates is confirmed by the work of the present author. Kathode rays are produced and allowed to issue in succession through two Lenard "windows" of aluminium foil. They then pass through a row of fine holes in a semi-cylindrical plate, and finally impinge on a photographic film, also semi-cylindrical. When the rays emerge in a strong magnetic field they form spectra. The paper is illustrated by two photographs selected from a number taken with various gas pressures, sizes of chamber, thicknesses of window, exposures, and field strengths. The work is still proceeding.
E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

824. *Electrical Properties of Thin Metal Films.* **J. Patterson.** (Phil. Mag. 4. pp. 652–678, Dec., 1902.)—This investigation was suggested by Longden's experiments on the electrical resistance of thin films deposited in vacuo by the kathode discharge [see Abstract No. 2214 (1900)]. The films were deposited by sputtering from a kathode of the metal required in vacuo; their thickness (in the case of the thicker ones) was determined by simultaneously depositing a film on optical glass which was measured by Wiener's optical interference method. In the case of the thinner films the thickness was calculated by comparing the time of deposition with that of one of the measured films. The electrical resistance was measured by a standard Wheatstone bridge. With bismuth films there appears to be an increase of specific resistance for the thicker films, but this is due to the surfaces losing their metallic lustre and becoming dull and powdery in appearance. In the case of platinum and silver films the specific resistance becomes smaller the thicker the film, the specific resistance being several times greater than that of the metal from which they are deposited. The specific resistance of platinum films that have been subjected to the same treatment remains constant above a thickness of 7×10^{-7} cm. Below this thickness the increase of specific resistance with decrease of thickness is very rapid. Heat decreases the resistance of both silver and platinum films, and the thinner the film the greater the decrease. In platinum films the greatest decrease is produced by passing an electric current through them; this is most likely due to the fact that the films are raised to a higher temperature. The values obtained for the mean free paths of the corpuscule in the metal are of the same order as those obtained from the change in resistance produced by a transverse magnetic field, viz., about 6×10^{-7} cm. [See also Abstract No. 1536 (1901).]
E. C. R.

825. *Conducibility and Retardation of Dielectric Polarisation.* **F. Maccarrone.** (N. Cimento, 4, pp. 313–360, Nov., 1902.)—The subject is the influence of duration of the electric field upon dielectric polarisation, and the effect of variable electrostatic fields and the corresponding dissipation of

energy in condensers exposed thereto. Any variation of the state of dielectric polarisation is equivalent to a movement of electricity parallel to the direction of polarisation; and when this is taken into account, the retardation of dielectric polarisation is easily explained, as also phenomena interpreted as due to a dielectric hysteresis. The author's method is based upon the orientation of a dielectric needle suspended in an electric field, and photographic recording of its movements by a reflected beam of light; account being taken of the fact that the attraction between two electric quantities depends upon the medium in which they are immersed. The polarisation of the dielectric is at every instant proportional to the deviation, when this is corrected for inertia. Needles of different substances were used; and the polarisation of the needle starts from a determinate value, instantaneously assumed by it when an electric field is formed in it, and then (except in paraffin) increases asymptotically to a maximum according to a law of the form polarisation $p = \mathrm{A} - \mathrm{B} . 10^{-ct}$, where A, B, c are terms depending on the nature and form of the substance considered, and A, B are in addition proportional to the field, there being a slow travel of charges across from the plates of the condenser to the surface of the movable dielectric. Assuming that in a dielectric the current does not necessarily follow Ohm's law, but is a function of the electromotive force ξ (first two terms only, of the form $a + b\xi$), we find that the corrected deviation is of the form $(\mathrm{A} + \mathrm{M}\epsilon^{-\lambda t} + \mathrm{N}\epsilon^{-\mu t})$, in which at first the last term is negligible. This gives values for the deviation which agree well with experiment. The resultant polarisation is proportional to the polarising field; and in the expression for current, above, a is proportional to and b is independent of the electromotive force; so that if X is the external field, ξ the resultant field in the imperfect suspended dielectric (due to the induced charges on its surface), and a' and b two constants depending on the substance of the imperfect conductor or dielectric, we have the current $u' = a'\mathrm{X} + b\xi$, which in the case of $a' = 0$ reduces to ordinary conductivity. In sinusoidal and rotating electrostatic fields we have, in addition to the above true current, a current of instantaneous displacement $u'' = \frac{k'}{4\pi} \cdot \frac{d\xi}{dt'}$, where k' is the dielectric constant for alternating fields of high frequency; and the whole current is $u = u' + u''$. The result is as if every elementary impulse due to an external field of a brief duration $\Delta t'$ left its own contribution, which disappears gradually and asymptotically with time. This explains "hysteretic viscosity" or dielectric viscosity. If the external field vary sinusoidally, the polarisation comes, after a more or less short interval, to assume sinusoidal variation, of the same frequency as the field, but with a certain lag; and the curves of dissipated energy present the form of hysteresis curves. The viscous resultant polarisation generally has a direction different from that presented at the same time by the variable exciting field; and this is a condition for rotation of the suspended dielectric needle. Conversely, the external field varies, following any rotation of the needle. A. D.

826. *Period and Inductance of Coils for Tesla Transformers.* **P. Drude.** (Ann. d. Physik, 9. 2. pp. 293–339, Sept., and 9. 3. pp. 590–610, Oct., 1902.)—In the construction of Tesla transformers it is necessary to bring into electric "resonance" the primary coil, consisting of a few turns with capacities attached at the ends, and the secondary coil with many turns but without attached end capacities. The present work, which is partly experimental and partly mathematical, was undertaken to throw light upon the practical problems here involved. Its chief results may be summarised thus: (1) The natural period of a coil increases with the dielectric constant of the core and its surroundings. (2) For Hertzian oscillations ebonite is electrically isotropic with a dielectric constant $\epsilon = 2{\cdot}79$. (3) The half-wave length $\frac{\lambda}{2}$ natural to a coil of length h and diameter $2r$, consisting of wire whose diameter and length are δ and l, the pitch being g, may be expressed in the form $\lambda/2 = l, f(h/2r,\ g/\delta,\ \epsilon)$, where ϵ is the dielectric constant of the core and f denotes a function whose values occupy pages 322–323 of the paper. Inside certain limits, this function multiplied by $\sqrt{h/r}$ gives a constant. (4) The half wave-length of a thin wire nearly closed to the form of a circle is about 6⅓ per cent. greater than the wire-length. (5) The "overtones" of a coil are not harmonically related to the fundamental. (6) By attaching capacity to a free end of a coil the period of its prime tone is increased. This increase is always less than the double period of the coil with free ends. Formulæ are given in this part of the paper to facilitate the calculation of periods and inductances of primary coils with capacities. (7) Secondary coils wound on wood or card tubes do not act so well as those wound on ebonite or glass or coreless coils. E. H. B.

827. *Photoelectric Current in Potassium Cells.* **E. v. Schweidler.** (Phys. Zeitschr. 4. pp. 136–137, Nov. 15, 1902.)—If a potassium cell with the potassium electrode as kathode is in the circuit of a battery, then by illumination of the kathode a current is produced whose intensity depends upon the intensity and colour of the illumination and the magnitude of the e.m.f. of the circuit. The present research deals with the dependence of the current on the e.m.f. employed. The following table gives relative currents for the various coloured lights, and illustrates the results obtained:—

PHOTOELECTRIC CURRENTS.

E.M.F. in Volts.	Colour of Light Used.			
	White.	Blue.	Yellow.	Red.
30	23·7	(26·4)	25·7	28·5
50	39·3	40·5	43·4	44·7
100	100	100	100	100
120	138	137	134	133
150	218	216	197	198
200	—	472	407	409

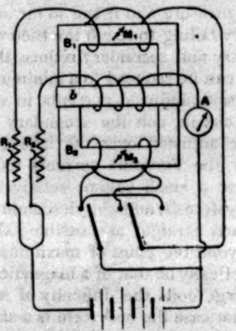
E. H. B.

828. *Induction Machines.* **H. Wommelsdorf.** (Ann. d. Physik, 9. 3. pp. 651–659, Oct., 1902.)—The induction machine is by far the most convenient where high potential is wanted without reference to quantity; but for Röntgen rays the quantity is too small for production of sufficient light, or the light is not continuous if Leyden jars be used, and the induction machine is too much influenced by the weather. The author has made an arrangement ("condenser machine") in which the rotating discs work between sectionally-divided plates of a large condenser. Constructive details and comparisons with older types. A model with condenser 24 cm. in diameter, a total height of 30 cm., a length of 28 cm., and a breadth of 22 cm. gives a greater electrical quantity than the largest induction machine. A. D.

829. *The Ruhmkorff Coil.* **G. Giorgi.** (Elettricista, Rome, 11. pp. 282–287, Dec., 1902.)—The author's theory is applicable to a Tesla transformer, without iron and fed by oscillating currents, but not to the actual Ruhmkorff. Taking a Ruhmkorff without iron in the secondary, we have the inertia of the current and also the impossibility of instantaneous interruption without a spark in the interrupter (hydraulic ram analogy) unless a condenser is used (analogous to an air-chamber to take the shock); and if this be small, there will be a spark in the spark-gap; if large enough there will be none, the energy being stored up in the condenser. The object, however, is to get as long a spark as possible. The iron core increases the electrodynamic inertia of the current and stores up energy; from this alone is the energy restored when the current is broken, subject, however, to losses by hysteresis, which may be reduced by a suitable air-gap whose reluctance is of about the same order as that of the core (while in most coils the air-gap is much larger than this). Further, for a maximum energy in the spark, the core should be of considerable volume. The condenser should have a capacity no higher than is absolutely necessary to prevent sparking upon breaking the primary current; and the more promptly the break is effected, the less need there is for a condenser. High frequencies tell in favour of this, and, therefore, indirectly in favour of the efficiency of the induction coil; but there is a limit to this, for the coil must have time to become fully charged, for large coils say 0·05 second, for small coils much less. The efficiency of the Wernelt interrupter is due to its high frequency and its promptitude of action. Then, as to the secondary coil, there is practically a limit to the increase of voltage on account of the thickness and the capacity of the secondary coil. This capacity is very difficult to locate and to measure, and it can so far only be traced through the voltage in the secondary failing to reach the theoretical amount. Magnetic leakages between primary and secondary reduce the inductive effect; with good construction these can be reduced to a minimum, but not in an ordinary straight-cored coil. Parasitic induced currents, in electric circuits anywhere on the same magnetic circuit, rob the secondary coil of its current; for example, the brass tube adjusted over the iron core, in which Foucault currents are induced, or the Foucault currents induced in the core itself. The primary should have a small volume relatively to the secondary; the core should have little hysteresis, and the descending part of the hysteretic curve should be as nearly straight as possible; the magnetisation should be not carried much beyond the point of maximum permeability; the form of the core should theoretically be that of a magnetic circuit with a very small air-gap; but for very large coils the difficulty of insulation would be very great, and probably in that case the best form is a straight core with a length very great relatively to its diameter. In any event the core should have a large section and volume, and be finely subdivided into wires or plates. The interrupter should be as rapid as possible, the frequency being made to depend on the density of the primary current. The condenser should just be large enough to prevent sparking and no more, and it must be thick enough to stand a maximum electromotive force. The primary should take the heaviest current, and that without overheating; and it is a good precaution to use still thicker wire than this, and to limit the effective density of the primary current by increasing the frequency of the interrupter. A. D.

830. *Combined Sliding-Contact and Plug Switch for Potentiometer and other Resistances.* **M. Edelmann.** (Elektrotechn. Zeitschr. 23. p. 1021, Nov. 20, 1902.)—In this arrangement the resistances are connected between the members of a circular series of contact-blocks over which is mounted a diametrically divided concentric metal ring. The sliding contacts are in the form of two series of metal strips bent at right angles at their ends, the upper halves of the strips in each series being bent upwards and the lower halves downwards. These two series of strips form bridge-pieces, and are mounted diametrically opposite each other on a rotary insulating disc whereby they can be turned so as to connect any two opposite contact-blocks with the metal ring. Beyond the path of these bridge-pieces, conical holes are formed in the ring, these holes being arranged co-axially, with correspondingly tapered holes in the contact-blocks, so that spring plugs can be inserted to connect the ring with any of the blocks beneath. The segments of the ring are each detachably secured in position by means of three studs with milled nuts. A potentiometer fitted with the switch is also described. C. K. F.

831. *A Universal Permeameter.* **R. V. Picou.** (Soc. Int. Elect., Bull. 2. pp. 828–834, Dec., 1902.)—Two iron horseshoes B_1 and B_2 are wound in series. The current in B_2 can be reversed as shown in the figure, and a branch circuit passes through an ammeter A and through a coil surrounding the specimen *b* whose permeability is to be measured. The specimen is inserted tightly between the ends of the horseshoes B_1 and B_2. For simplicity of explanation imagine two magnetometers M_1 and M_2 introduced into the substance of the horseshoes; they will measure the magnetic fluxes in B_1 and B_2. There are two operations: (1) Send a current in B_1 and B_2 so that the flux in them is in the same direction. Nothing passes along *b*, since its ends are at the same magnetic potential—but the flux traverses *all the joints.* The magnetometers measure the flux in B_1 and B_2; let this be Φ. (2) Reverse the current in B_2; the fluxes in B_1 and B_2 will be now opposed and the two circuits will be closed by passing through *b*, the flux is reduced by the introduction of the reluctance of *b*. Pass such a current round *b* that the flux in B_1 and B_2 returns to its value Φ. Let $R =$ reluctance of B_1 and B_2, and let $r =$ reluctance of *b*. Let F and *f* be the magneto-motive forces in B_1, B_2 and in *b*. Then in the first experiment $\Phi . 2R = F$. In the second experiment $\Phi . 2R + 2\Phi . r = F + f$, hence $2\Phi . r = f$. Now $\Phi = B . S$ (where $S =$ cross-section of horseshoes); $f = 4\pi\mu i$ (where $i =$ current in *b*): $r = l/\mu$ (where $b =$ length and $\mu =$ permeability of *b*); hence μ can be ascertained.



In reality the flux is found by a special ballistic galvanometer instead of by the magnetometers, and there are other modifications which render the instrument a reliable commercial instrument. P. E. S.

832. *A Registering Maximum Current Indicator.* **H. Marxen.** (Elektrotechn. Zeitschr. 23. pp. 1081–1083, Dec. 11, 1902.)—This instrument, constructed by the firm of Hartmann and Braun, Frankfort-on-Main, is based on the same principle as the spring galvanometer of Kohlrausch. Inside a solenoid is suspended a movable soft iron plunger with its upper end attached to a vertical spring. A style is rigidly fixed to the plunger so that when the latter is sucked into the solenoid a vertical radial line is drawn from the centre of a toothed cardboard disc. At the same instant a weight is released which works a pawl and ratchet-toothed wheel, and the cardboard disc is turned through the distance of a single tooth. The lengths of the radial lines indicate the strength of the current, and the cardboard disc is graduated in amperes by means of concentric circles; in the case of a short circuit the style is drawn off the disc altogether. The instrument would be useful in accumulator circuits or in central-station work to indicate consumers' maximum demand. E. S. A. R.

833. *Pocket Voltmeter.* **J. A. Montpellier.** (Électricien, 23. pp. 385–386, Dec. 20, 1902.)—This instrument is primarily designed for the measurement of the true volts in batteries used for lighting automobiles and is constructed on the hot-wire principle [see Abstract No. 76 (1902)]. By this means any large increase in resistance inside the battery is at once detected. The designers—Chauvin and Arnoux—claim that the instrument is entirely free from self-induction and from the influence of magnetic fields. Contact is made by two pivoted horn-shaped conductors, which fold up behind the instrument when not in use. The voltmeter is made in three sizes: (1) 0 to 1·5 volts for voltaic elements; (2) 0 to 2·5 volts for accumulators; and (3) 0 to 6 volts for sets of three accumulators or five voltaic elements. E. S. A. R.

ALTERNATING CURRENTS AND MAGNETISM.

834. *Transformation of a Pulsating into an Alternating Current.* **D. A. Goldhammer.** (Phys. Zeitschr. 4. pp. 108–110, Nov. 1, 1902. Communication from the Physikalischen Inst. der Universität Kasan.)—The author gives several methods for the above transformation, on the following principles. The pulsating current may be regarded as a continuous current on which is superimposed an alternating current (generally asymmetric). In one of the methods the continuous part of the pulsating current (in that part AB of the circuit, in practice of small self-inductance, where the alternating current is required) is neutralised by connecting the ends of AB to a secondary battery; in this auxiliary circuit is placed also a large inductance so as to confine the alternating current to its proper path AB. In another method AB is the "bridge" in a Wheatstone qnadrilateral balanced for steady currents, so that in AB there is no continuous current; two opposite arms of the quadrilateral have great inductance, the other two none, and the required result is thus obtained. W. S.

835. *The Vibration of Wires in a Varying Magnetic Field.* **K. Honda** and **S. Shimizu.** (Phil. Mag. 4. pp. 645–652, Dec., 1902.)—It has been shown

by many experimenters that sounds can be heard in ferro-magnetics when magnetised or demagnetised. Some of the above observations may have been caused by mechanical action between the coil and the ferro-magnetic core, but in some cases the sounds must be attributed to the magnetic expansions of the cores. The authors subjected wires of iron and nickel to alternating fields of frequencies up to 150; they observed the change in length by Nagaoka's well-known method and found that the sounds must be attributed to the magnetic expansions, for no sounds are heard except with ferro-magnetics. The singular result was obtained for iron and nickel that the amplitude of the magnetic expansion varies with frequency of alternation of the field, and that there are sharp maxima and minima, whose positions vary as the tension in the wire varies. P. E. S.

836. *The Earth-Current Question.* **P. Bachmetjew.** (Acad. Sci. St. Pétersburg, Mém. 12. 3. pp. 1–55, 1902.)—The author considers that Kelvin in 1892 disposed of the assumption of direct magnetic or electric influences of the sun on the magnetic elements, and also that the cause of earth currents is not to be found in atmospheric electricity. He then reviews the experiments and observations on the diurnal variation, the direction (mostly from S.W. to N.E.), the potential difference (influence of horizontal and vertical distance of the electrodes) of earth currents and on their connection with the magnetic elements and meteorological phenomena. His own experiments were conducted at twelve stations in Bulgaria in the years 1883 and 1893 to 1896, and concern, as special features, the solar eclipse of August 9, 1896 (no direct influence traceable, but there was also thunder and rain); the earthquake of August 31, 1894; and the daily fluctuations in the height of the underground water, whose minimum level coincides with the minimum earth temperature at a depth of 25 cm. The sun heat seems to be one of the chief sources of the earth currents. The average extreme of air temperatures at his twelve stations were a maximum at 2.30 p.m. and a minimum at 5.30 a.m.; his earth current maximum occurs at 3.45 p.m., his minimum at 7.30 a.m. The coincidences are more distinct when the temperature of the soil is taken; but the earth current has two maxima and two minima within twenty-four hours. These thermoelectric currents are stronger in mountainous regions than in the great plains, and their direction is, in daytime, from below upward. A second source lies in the percolation of water through porous clay (diaphragm currents of G. Quincke of 1859), sand, and earth; the author and P. Pentschew observe that the potential difference of these currents increases by 5 per cent. with a temperature rise of 1°. This accounts for the seasonal variations in earth currents, and their diminution after heavy rains. Apart from these percolation earth currents are stream currents, due to the movements of the underground water. On a prehistoric mound near Sophia the direction of the earth current changed, when a rivulet flowing past it became dried up, and the currents were strongly perturbed when the mound was artificially watered for half a day. The cooling of the earth crust furnishes a third source for the earth currents. Together with S. Stamboljeff, Ch. Christodulos, and Ch. Georgjeff, the author has experimented on electric currents arising in molten metals when near their point of solidification; these currents are ascribed to a discharge of ether (contracting metals, *e.g.*, Sn), or an absorption of ether (expanding metals, *e.g.*, Bi). The direction of this cooling current in tin is, at Sophia, the same as that of the prevailing earth current. Such cooling currents would be produced during earthquakes and continue after them, owing to the heating of the disturbed

strata. The author also mentions experiments of his of 1895 on currents generated in locally heated closed metallic circuits. Changes of the state of aggregation (melting of snow), friction (tides), and plant life would further contribute to explain the variety of earth current phenomena with which the earth magnetism seems to be intimately connected. The memoir was presented in 1901, and there are few literature references of the years immediately preceding that date. H. B.

837. *Magnetic Observations on the Kaiserstuhl, Baden.* (Nature, 67. p. 187, Dec. 25, 1902.)—Within a district of about 150 sq. km., 400 determinations were made of the declination and 140 of the inclination; the declination varied between 8·7° W. and 20·8° W., the inclination between 56·6° and 72·0°, the horizontal force between 0·173 and 0·227 c.g.s. The basaltic rocks behave as if they were vertical magnets with their north poles—not south poles—uppermost. H. B.

REFERENCES.

838. *Theory of Plane Condenser.* **N. Boulgakow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. No. 6 b. pp. 315–325, 1902.)—In the first part of this paper a deduction of the fundamental formulæ is given, the second part being given up to constructing the equipotential surfaces found to afford a practically plane condenser. A. G.

839. *Resonance Method for Determining the Period of an Oscillatory Discharge.* **P. Drude.** (Ann. d. Physik, 9. 3. pp. 611–618, Oct., 1902.)—The author describes a convenient method of finding the wave length from condenser oscillations by a pair of parallel wires and vacuum tube. [See also Abstract No. 1875 (1902).] E. H. B.

840. *Recent Oscillographs.* **A. Blondel.** (Écl. Électr. 31. pp. 41–50, April 12; and pp. 161–168, May 3, 1902.)—The author discusses the theory of the Oscillograph, and describes the principal recent forms of the instrument. G. W. DE T.

841. *Magnetic Leakage in Alternate-Current Apparatus.* **A. Pugliese.** (Elettricista, Rome, 11. pp. 216–221, Sept., and pp. 242–245, Oct., 1902.)—The methods of Blondel, Behrend, and Heyland for representing the action of alternate-current apparatus by vector diagrams are discussed and compared. A. E. L.

842. *Compensation of a Ship's Compass.* **H. Meldau.** (Phys. Zeitschr. 3. pp. 554–558, Sept. 1, 1902.)—The well-known expressions for semicircular and quadrantal deviations are discussed in connection with the Kelvin compass, and with that used in the German Imperial Navy. P. E. S.

843. *Steel used in Electric Machines.* **G. Charpy.** (Soc. Int. Élect., Bull. 2. pp. 835–845; Discussion, pp. 845–846, Dec., 1902.)—The new science of the minute structure and properties of metals, called metallography, takes into account (1) the chemical elements in the metals; (2) the previous heat treatment; (3) the mechanical deformations. The author particularises in the cases of cast iron and steel, showing how the microscopic appearance varies according to each of these conditions. In summarising present knowledge, he points out that the small grains of pure iron (ferrite) found in steel may be in reality identical with the minute magnets supposed by Ewing in his theory of magnetism. Experience points to the fact that steels made by the Bessemer process age more quickly than those made by the Martin process. P. E. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

844. *Atomic Weight of Cerium.* **B. Brauner** and **A. Batěk.** (Zeitschr. Anorg. Chem. 34. 1. pp. 103–124, Feb. 5, 1903.)—This first part of a revision of the atomic weight of cerium may be resumed as follows: 1. The analyses of the sulphate and oxalate made by the authors (these salts being prepared from cerium purified by different combined methods, eliminating, first of all, any traces of more negative earths) afford an evidence that the value hitherto obtained, viz., Ce = 140·25 is very near the true value of the atomic weight of cerium. 2. On the other hand, the figure obtained by Wyrouboff and Verneuil, viz., Ce = 139·38, has to be regarded as incorrect, as none of the materials obtained from different fractions of pure cerium gave any smaller figures than 140, experiments being carried out with the utmost care. 3. The figures obtained with sulphate dried at too low temperatures, so as to be only partially free from water, approach the values given by the above experimenters. 4. The purest cerium tetroxide, as obtained by the authors by heating the sulphate, has to be regarded as the purest product obtainable, its colour being white with a slight tint of "chamois." 5. The perfectly white tetroxide, as prepared by Wyrouboff and Verneuil, was not obtained by any of the various modified methods of purification, nor in any of the fractions prepared. A. G.

845. *Atomic Weight of Cerium.* **B. Brauner.** (Zeitschr. Anorg. Chem. 34. 2. pp. 207–238, Feb. 26, 1903.)—The value of the atomic weight of cerium, as formerly obtained in collaboration with A. Batěk, viz., Ce = 140·25 (see preceding Abstract), is found to represent the true value but for a slight uncertainty in the second figure. The value given by Wyrouboff and Verneuil (Ce = B9·88), improbable in itself on account of the true atomic weight of the neighbouring lanthanum being La = B9·04, is found to be too small [see Abstract No. 494 (1903)]. Perfectly white cerium tetroxide turns out not to be entirely pure. A. G.

846. *Potential Difference of Alloys and Film-formation.* **F. Haber.** (Zeitschr. Elektrochem. 8. pp. 541–552, Aug. 7, 1902.)—The author [see Abstracts Nos. 261 (1900) and 176 (1903)] has already shown that the disintegration of kathodes in alkali solutions is due to the electro-chemical formation of alloys composed of the material of the kathode and an alkali metal; these alloys are then disintegrated by the water. The alloys may be prepared by the ordinary chemical processes, and the author was therefore able to make measurements of p.d. with them, but he did not formerly consider the bearing of what Ostwald calls film-formation (Deckschichtenbildung) on the experimental values obtained; the formation of a thin coherent film of the nobler metal on the surface of an alloy immersed in an electrolyte is not uncommon. The author now discusses the subject with the view of making his explanation of the disintegration of kathodes more complete. D. H. J.

847. *Changes of Atmospheric Nucleation.* **C. Barus.** (Science, 16. pp. 948–952, Dec. 12, 1902. Paper read before the American Physical Society, Oct. 18, 1902.)—Using the methods described in earlier papers [see Abstracts

Nos. 40, 148, 149 (1903)], the author gives results of experiments to estimate the number of nuclei in the atmosphere, and the variation with change of weather conditions. These results show extreme variability of atmospheric nucleation, not due, or only to a small extent due, to local effects, but corresponding to weather conditions. During rain, pronounced minima are always to be observed. This implies a removal of nuclei by precipitation in a saturated atmosphere more rapid than the supply of nuclei to the same region. As rain tends to change the normal air potential from positive to negative, we have thus minimum nucleation existing here concurrently with maximum negative ionisation. Sharp minima also occur contemporaneously with the passage of dense cloud masses over the sky, higher values usually appearing again as soon as the sky is clear. The author's explanation is that the air has moved bodily with the cloud, the whole constituting a region of low nucleation. The nuclei may have been precipitated by rain elsewhere, and the cloud may even have vanished from the region. So far as the observations go, there is no evidence that solar radiation is the producing cause of nuclei, and their origin has yet to be determined. W. C. H.

848. *Solubility of Boric Acid in Hydrochloric Acid.* **W. Herz.** (Zeitschr. Anorg. Chem. 33. 3. pp. 355–357, Jan. 5, 1903.)—The author tests Dammer's statement that boric acid should be more soluble in hydrochloric acid than in water. Boric acid was agitated in a thermostat at 26° with an excess of aqueous hydrochloric acids of different normalities. After saturation, a given volume of clear solution was taken away with a pipette, the total acidity being ascertained by titration. Deducting the amount of alkali required by the known normality of the hydrochloric acid used, the remaining alkali gave the amount of boric acid dissolved. It results from these determinations that the solubility of boric acid, contrary to the above statement, will decrease for increasing amounts of hydrochloric acid, reaching a final value, which is constant within the limits of possible error. This decrease of solubility is too great to be due to a diminution in the dissociation by the K-ions of the hydrochloric acid, as boric acid is but slightly dissociated. The author accordingly suggests that similar conditions might exist in the present case, as stated by Sackur (Ber. Deutsch. Chem. Ges. 35. p. 1242), for the decrease of solubility of bases in bases and of acids in acids. A. G.

849. *Tetragenic Double Salts.* **W. Meyerhoffer.** (Zeitschr. Anorg. Chem. 34. 2. pp. 145–174, Feb. 26, 1903.)—A tetragenic salt, *i.e.*, a salt made up of four different radicles (ions), apart from crystal water, will exhibit two or three temperatures of formation, those corresponding to Kaïnite ($MgSO_4 . KCl . 3H_2O$) being 76° and 85° respectively. The author discusses the notion of "characteristics of a solution," the applicability of which is shown by some examples. The *polythermal* of kaïnite, *i.e.*, the curve representative of its equilibrium phenomena at variable temperature, is developed for the whole region of its existence, it being inferred that, in addition to the above two temperatures of formation, there must exist two more secondary ones, one of which is possibly unstable. Discussing the three possible formulæ for kaïnite, the author arrives at the conclusion that the formula $MgSO_4 . KCl . 3H_2O$ is experimentally the most probable. By considering the formation of natural hard salt deposits, the result is obtained that the latter are not produced by rapid lixiviation of carnalite and kieserite, at least not in all cases. Three processes relative to the treatment of kaïnite (those of Douglas, Precht, and the Westeregeln Works) are finally considered from the point of view of the phase rule, it being shown that the guiding principles for these processes may accurately be studied on the latter. [See also Abstract No. 1588 (1901).] A. G.

850. *Molecular Diminution of Velocity of Crystallisation by the Addition of Foreign Substances.* **E. v. Pickardt.** (Zeitschr. Phys. Chem. 42. pp. 17–49, Oct., 1902.)—The velocity of crystallisation of an overcooled liquid, expressed in millimetres per minute, varies with the extent of the overcooling expressed in centigrade degrees; the velocity at first increases slightly with the overcooling, remains almost constant over a considerable range of temperature and then falls very rapidly, possibly because the heat liberated by the crystallisation is no longer sufficient to raise the substance to the melting-point. The velocity is very greatly diminished by the presence of impurities. These results are clearly shown in the figure, which gives the crystallisation velocity for different degrees of overcooling of (1) pure benzophenone and (2) a mixture of 100 mols. benzophenone and 8 mols benzoicacid. The diminution in the velocity of crystallisation is, for moderate concentrations only, proportional to the square root of the percentage number of molecules of impurity. Thus Fig. 2, which shows the effect of benzoic anhydride on benzophenone, would cut the axis at 13 mols. $(C_6H_5 . CO)_2O$ per 100 mols. $(C_6H_5)_2CO$ if the square-root law held good. The effect is in most cases the same for equimolecular quantities of different substances and can, therefore, be made the basis of a method of determining molecular weights. The diminution of velocity in mm. per minute $= k \sqrt{c}$ where c is the concentration of impurity in mols. per 100 mols. of solvent and the average velocity of the constant is 17·1 for solutions in benzophenone. Normal results were obtained for 26 compounds, but abnormal results were obtained for (1) nitrobenzaldehyde, dinitrobenzene, and azobenzene, which appear to exist in double molecules; (2) nitrotoluene, which appears to be trimolecular; (3) quinone, which appears to be tetramolecular; and (4) resorcinol, which behaves as if it had only half the normal molecular weight. T. M. L.

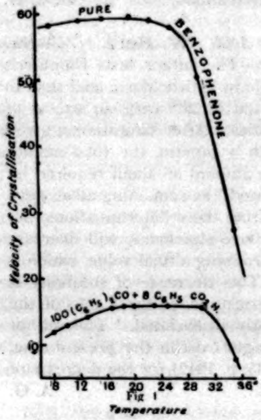


Fig 1

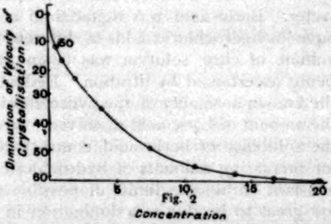


Fig. 2

851. *The Dissociation-Constant of Water and E.M.F. of a Gas-battery.* **G. Preuner.** (Zeitschr. Phys. Chem. 42. pp. 50–58, Oct., 1902.)—The dissociation-constant for carbon dioxide in the equation $2CO + O_2 \rightleftarrows 2CO_2$ has the value $K_1 = 13 \times 10^{-13}$ at 1,000°, this being the mean of six numbers ranging from 10·8 to 17·2 and calculated from the measurements of Le Chatelier. The dissociation-constant for the equation $CO_2 + H_2 = CO + H_2O$ is calculated from Bardouard's measurements to be $K_2 = 2$ at 1,000°. From these two equations the dissociation-constant for water in the equation $2H_2 + O_2 \rightleftarrows 2H_2O$ is calculated to be $K_3 = 5{\cdot}2 \times 10^{-12}$ at 1,000° or $5{\cdot}7 \times 10^{-78}$ at 20°. From this constant it is further deduced that the e.m.f. of the gas-battery should be 1·15 volts, the observed value being 1·10 to 1·20 volts. Such a close agreement could scarcely have been expected considering the difficult character of the experiments on which the calculations are based, and the number of auxiliary assumptions that have to be made. T. M. L.

852. *Radium.* **F. Giesel.** (Ber. Deut. Chem. Gesell. 36. pp. 342–347, Feb. 7, 1903.)—A solution of 1 grm. of "5 per cent." radium bromide liberated in 16 days 3·5 c.c. of gas containing 78 per cent. hydrogen and 17 per cent. oxygen, whilst the solution became coloured with bromine. Radium thus sets up a kind of electrolysis, the kathion being hydrogen and the anion hydroxyl or bromine. It is calculated that the 5 cg. of radium bromide generate (or transform) in this way energy to the extent of 1·8 watt.-secs. = 0·42 cal. = 18,000 g. cm. per day. T. M. L.

853. *Dissociation and Polymerisation of Nitroso-Compounds.* **E. Bamberger** and **R. Seligman.** (Ber. Deut. Chem. Gesell. 36. pp. 685–700, March 7, 1903.)—The tertiary nitroso-paraffins, such as nitrosobutane $C(CH_3)_3.NO$ and nitrosopentane $C_2H_5.C(CH_3)_2.NO$, are blue when in a monomolecular state, but like nitrogen peroxide readily polymerise to colourless bimolecular compounds. Thus the blue ethereal solutions deposit colourless crystals, and the evaporation of the last trace of ether is accompanied by the abrupt bleaching of the whole mass. The depolymerisation is, however, by no means instantaneous, and when the colourless crystals are dissolved the solution only gradually develops a blue colour. By determining at short intervals the freezing-point of a freshly-prepared solution in benzene the gradual change of the bimolecular into the monomolecular compounds was followed, and was found to continue during four hours and to correspond exactly with the development of the blue colour. Contrary to all previous observations on the influence of solvents on the velocity of chemical change, the depolymerisation was found to be most rapid in chloroform and benzene and least rapid in oxygenated solvents such as acetic acid and ethyl acetate, whilst in aqueous solutions the blue colour was developed exceedingly slowly and even at the boiling-point required several seconds to reach a maximum. Sunlight retards the depolymerisation. Marked differences in properties were found between the two forms, the blue form being more soluble, less stable and possessing a sharp, pungent smell. T. M. L.

854. *Electromagnetic Behaviour of Amalgams and Alloys.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 558–576, Jan. 31, 1903.)—The author some time ago developed the accurate expression for the potential difference between any (solid or liquid) solution of two metals on one hand, and an electrolyte including the ions of both metals on the other. He is now publishing some considerations made in connection therewith. Supposing a solution of both metals to be possible in any proportions, the following formula is easily deduced :—

$$\Delta = \frac{\mu_{m1} - \mu_{e1}}{\nu_1 \epsilon} = \frac{\mu_{m2} - \mu_{e2}}{\nu_2 \epsilon},$$

where Δ is the difference of the electrical potentials on both sides of the electrical double layer, μ_{m1} and μ_{e1} representing the thermodynamic molecular potentials of the first metal in the amalgam, and of the corresponding metal ions in the electrolyte respectively, and similarly for μ_{m2} and μ_{e2}; ν_1 and ν_2 being the valencies, and ϵ the charge of a grm. equivalent. This formula is transformed into a formula expressing the value of Δ for any temperature, without any ambiguity. Taking for the constants occurring in the same, the values, as determined by Wilsmore, the following relation is arrived at—$\Delta = \Delta_1 + 0{\cdot}0289 \log_{10} (1 - x)$, M_1 being tin, and M_2 mercury. From this, it may be inferred that even for $x = 0{\cdot}999$, Δ is but little different from the value Δ_1, corresponding to $x = 0$ (pure tin), and differs very much from the value Δ_2, corresponding to $x = 1$ (pure mercury), even though the amalgam be nearly pure mercury. After next developing a more accurate expression for Δ, the case of a maximum or minimum is discussed, when the amalgam will separate into two coexisting phases of different composition. The case of both metals being very closely related to each other, as to their electromotive behaviour, is next considered, and some remarks relative to the curve $\Delta = f(x)$ are finally made, in the case of the amalgam not being liquid (or solid) for *any* value of x, but capable of forming two coexisting phases.

A. G.

855. *Conductivity of Hydrasine and Substances Dissolved therein.* **C. A. L. de Bruyn** and **E. Cohen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 621–627, Feb. 28, 1903.)—The investigation of the conductivity of non-aqueous solutions has shown that such laws and rules as are true in the case of aqueous solutions do not apply to other solvents. From the physical properties of free N_2H_4, it was, however, to be anticipated that this liquid should exhibit a strong ionising power. It is known, in fact, that between the dissociating power of a liquid on the one hand, and the degree of association of the molecules, the dissolving power and the dielectric constant on the other, there exists a certain parallelism. This rule is shown to be true in the case of hydrasine. The authors successively test solutions of H_2O, KCl, KBr, KI Na and H_3N in N_2H_4. From the results obtained, the conclusion is drawn that hydrasine, as regards its ionising power, is comparable with water. With regard to mixtures of hydrasine with water it is safe to state that by adding water the conductivity is first caused to decrease, then for a mixture of about 60 mol. H_2O and 100 mol. N_2H_4 reaches a minimum and finally increases. The minimum thus does not coincide with the composition $N_2H_4 + H_2O$ of the so-called hydrate.

A. G.

856.* *Current Flow in Electrolytes.* **A. H. Sirks.** (Konink. Akad. Wetensch Amsterdam, Versl. 11. pp. 543–550, Jan. 31, 1903.)—When etching metal surfaces by means of the electric current, as described in a previous paper [see Abstract No. 174 (1903)], a great difficulty was encountered. In some cases the hydrogen evolved at the kathode was found to disturb the operation, whenever, in fact, the latter, instead of escaping readily, adhered to the object to be etched upon, and which served as anode. To avoid this, the author surrounded the kathode with fine metal gauze, when, after the operation, the wires of the latter turned out to be covered with a copper deposit having the form of the electrodes. In order to ascertain the cause to which the formation of "these copper images" is due, the following experiment was made. Instead of water acidulated with sulphuric acid, a saturated copper sulphate solution was chosen as electrolyte, the electrodes being two coins. The wires to which they were soldered, as well as the backs of the coins, were varnished, except the portion in contact with the electrolyte, so as to make sure that only the two sides of the coins turned towards one another acted as polar plates. The metal gauze envelope was replaced by a quadrangular platinum plate, attached to an insulated support, between the electrodes, when, immediately on completing the circuit, a sharply limited round copper deposit was noted on the side turned towards the anode, which changed only in thickness, but not in size. A minimum image would be obtained when the platinum screen was placed in the middle between the electrodes, thus pointing to a small contraction towards the middle of the current flow, giving rise to the phenomenon. As current lines will leave the electrodes in all directions, there must have been a cause at work compelling some current lines to prefer the longer way round the platinum screen to the shorter way through the same. This cause of deviation is found to be due to polarisation phenomena. The author is, however, unable to explain the remarkably sharp edges of the images. A. G.

857. *Some Laboratory Observations on Aluminium.* **C. F. Burgess** and **C. Hambuechen.** (Electrochem. Ind., Philadelphia, 1. pp. 165–168, Jan., 1903.)—After a discussion of a number of the properties of aluminium and of the sometimes discrepant statements regarding these, the authors communicate some measurements of the potential of an aluminium electrode immersed in various aqueous solutions, their figures being given in the following table :—

Time in hours.		0	·5	1·5	5·0	6·2	21·6	27·9	77·9	99·9
No.	Solution.	Potential in Volts.								
1	KCl	·370	·226	·226	·226	·307	.220	·235	·232	·250
2	$AlCl_3$	·382	·235	·220	.220	·310	·211	·220	·230	·220
3	$AlCl_3$	·361	·211	·205	·211	·250	·199	·220	·214	·217
4	HCl	·406	·256	–·062	·211	·271	·250	·250	·232	·232
5	H_2SO_4	·400	·121	·139	·151	·220	·169	·160	·130	·130
6	HNO_3	·220	·040	·040	·040	·040	–·023	·010	–·032	–·017
7	NaOH	1·120	1·000	·964	·889	·769	·790	·721	·925	1·090
8	NaOH	1·147	·976	·913	·826	·805	·220	·880	·820	·874
9	HF	·430	·382	.397	·238	·250	·229	·223	·370	·289
10	NH_4Cl	·367	·232	·274	·580	·610	·235	·232	·250	·310
11	NH_4F	·925	·616	·595	·556	·211	·217	·370	·400	·454
12	KF	·010	–·050	–·053	–·023	–·023	–·068	–·008	–·026	–·053
13	KF	·223	·346	·445	·652	·610	–·026	·022	·100	·040
14	Mix. *a*	·925	·370	·319	·280	·250	·220	(*)	·274	·262
15	Mix. *b*	·760	·850	·820	·790	·778	·529	·286	·187	·235

(*) On allowing current to flow, potential rose from ·220 to ·408 volt.

Solutions 1, 4, 5, 6, 7, 9, 10, 11, and 12 were normal solutions ; 2 was dilute solution of aluminium chloride, commercial ; 3, dilute solution of pure aluminium chloride ; 8 was 0·1 normal solution of sodium hydroxide ; 13, a 0·1 normal solution of potassium fluoride ; 14, a mixture of equal parts of normal ammonium chloride and normal ammonium fluoride ; 15 was a mixture of normal ammonium chloride and 0·1 normal potassium fluoride. From the data obtained the authors conclude that of the various salts tested, ammonium fluoride would be the best material to use in connection with aluminium for battery purposes. Tests showed that an aluminium-consuming cell of this type would set up a pressure of almost 2 volts; but full tests have not yet been made. The variations of the potential of the aluminium electrode with time have also to be studied more fully. Temperature has also an important bearing on the potential, rise of temperature producing as a rule an increase in the single potential. A. F.

858. *Formation of Metal Oxides. II.* **A. Coehn** and **Y. Osaka.** (Zeitschr. Anorg. Chem. 34. 1. pp. 86–108, Feb. 5, 1903.)—The principal results arrived at in this paper are as follows:—(*a*) The oxidation potentials of some metals are recorded. (*b*) The values corresponding to the evolution of gaseous oxygen are measured for a series of metals and oxides. (*c*) Out of the two anodic discontinuities in the evolution of oxygen, the first, reversible, point —1·11 with respect to hydrogen in the same solution—is independent of the metal of the anode. The second, non-reversible, point, however, proves to be dependent on the material of the anode, varying, for the materials tested, between 1·28 and 1·75 volt, with respect to hydrogen in same solution. (*d*) An interpretation is given of the phenomena connected with the electrolytic evolution of oxygen, based on the results here recorded, as well as on the outcome of Gräfenberg's researches on the formation of ozone. (*e*) On a nickel anode in potassium hydroxide no ozone is evolved, even with potentials superior to 3 volts, whereas under similar conditions a strong evolution of ozone is observed on platinum anodes. (*f*) An oxygen electrode rapidly adjusted and rapidly following any variable charges is described. (*g*) Electrolytic decomposition of water may be carried out on an industrial scale, even at lower pressures than are possible when using platinized platinum anodes. [See also Abstract No. 589 (1903).] A. G.

REFERENCES.

859. *Action of a Metallic Oxide or Hydroxide on Solutions of Salts of other Metals. Basic Mixed Salts.* **A. Mailhe.** (Annal. Chim. Phys. 27. pp. 362–397, Nov., 1902.)—Crystalline basic mixed salts have been obtained of mercury with copper, zinc, nickel, manganese and cadmium, and basic mixed chlorides, bromides, sulphates and nitrates of copper with zinc, nickel, cobalt, manganese, and cadmium. T. M. L.

860. *Maxwell's Theory in Reference to Electrolysis.* **G. Platner.** (Elektrochem. Zeitschr. 9. pp. 55–63, June, and pp. 123–129, Sept., 1902.)—This is a mathematical paper in which the author shows that all the phenomena of electrolysis are capable of explanation on the basis of Maxwell's theory. W. S.

861. *Electricity from Carbon.* **Bermbach.** (Elekt. Runds. 19. pp. 241–242, Aug. 15, 1902. Paper read before the Elektrotechnische Gesellschaft at Cologne.)—A brief but clear account of the different attempts to obtain electricity from carbon or coal without an intermediate convertion of heat into mechanical work. D. H. J.